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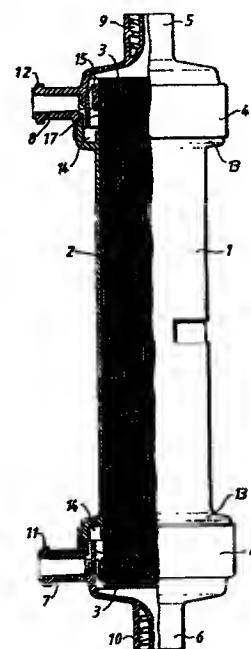
(54) An apparatus for effecting mass and/or heat transfer.

(57) An apparatus is described for effecting mass and/or heat transfer, including a cylindrical open-ended housing (1) closed by two end caps (4), each provided with an inlet (5) or an outlet (6) for a first fluid intended to flow through a bundle of hollow fibers (2) arranged within the housing (1) between two end walls (3), at least one of said end caps being provided with an outlet (8) for a second fluid intended to be removed from the space outside the fibers (2), the inlets and/or outlets (5-8) provided in one and the same end cap being separated by the adjacent end wall (3).

The apparatus described is characterized by a ring (15) arranged in the housing (1) and/or the end cap in such a way that a channel or channels (17) is/are provided, connecting said outlet (8) for the second fluid with the space outside the fibers (2).

Preferably the apparatus according to the invention is intended for hemofiltration, hemodiafiltration or hemodialysis. It may, however, also be used for dialysis in general or filtration in general and for heat transfer or as an oxygenator.

Fig.1



**TECHNICAL FIELD**

The present invention relates to an apparatus for effecting mass and/or heat transfer, including a cylindrical open-ended housing closed by two end caps, each provided with an inlet or an outlet for a first fluid intended to flow through a bundle of hollow fibers arranged within the housing between two end walls, at least one of said end caps being provided with an outlet for a second fluid intended to be removed from the space outside the fibers, the inlets and/or outlets provided in one and the same end cap being separated by the adjacent end wall.

Devices of the above kind are used for e.g. different kinds of medical treatments such as hemodialysis, hemofiltration, plasmapheresis and immunotherapy. Other fields of use are, for instance, dialysis in general and filtration in general, for example in connection with cleaning or desalination of sea water. The apparatus according to the invention may also be used as a heat exchanger or as a blood oxygenator.

**TECHNICAL STANDPOINT**

The apparatus according to the invention may be said to be an improvement or a modification of the apparatuses disclosed in, for instance, US-A-4 990 251, US-A-5 002 668, EP-A1-0 305 672 and EP-application 91.101006.4, which, however, all have the inlets and outlets for the second fluid arranged as nipples on the housing, providing rather complicated tools for the manufacture of the housing.

In US-A-4 724 900 an apparatus is described having said inlets and outlets arranged in the end caps. A disadvantage of said design is that the housing has to be provided with openings in front of the inlets and outlets for one of the fluids.

**DESCRIPTION OF THE INVENTION**

One object of the present invention is to eliminate or at least reduce the above problems. This is made by providing an apparatus for effecting mass and/or heat transfer, including a cylindrical open-ended housing closed by two end caps or headers, each provided with an inlet or an outlet for a first fluid intended to flow through a bundle of hollow fibers arranged within the housing between two end walls, at least one of said end caps being provided with an outlet for a second fluid intended to be removed from the space outside the fibers, the inlets and/or outlets provided in one and the same end cap being separated by the adjacent end wall, characterized by a ring arranged in the housing and/or the end cap in such a way that a channel or

channels is/are provided, connecting said outlet for the second fluid with the space outside the fibers.

Thanks to the invention you may use a very simple and inexpensive housing which can be made either by injection moulding or blow moulding in simple moulds or forms. Also the handling of the housing is simplified in connection with the manufacturing of the complete apparatus. Other advantages will be mentioned in the following.

Preferably one of the end caps is provided with an inlet for said second fluid and the other end cap with an outlet for the same fluid. Such an apparatus may be used for dialysis and also for pure filtration. However, in connection with filtration you don't need any inlet for the second fluid.

In order to get a good sealing between the two fluids, which may be liquids and/or gases, the ring is preferably partly moulded into the adjacent end wall.

In a preferred embodiment of the apparatus according to the invention the ring consists of an inner part facing the fibers and intended to support the fibers during the moulding of the adjacent end wall and an outer part facing the housing and/or the end cap and being supported by the housing and/or the end cap. Said inner and outer parts may be separated by one or more ducts which are filled with the moulding material in connection with the moulding of the end walls. Thanks to this design you get a good sealing at the same time as the distribution of the moulding material is facilitated.

A simple design is achieved, if said channel or channels is/are arranged between an inner wall of the housing and an outer wall of the ring. Such a design gives you a further advantage that the end walls, which normally are made by moulding polyurethane (PUR), may be prevented from reaching the housing,

The mounting of the bundle of hollow fibers is facilitated, if the inner main wall of the housing and the inner wall of the ring are essentially in line supporting the bundle of the hollow fibers during the moulding of the end walls.

A good sealing will also be provided, if the end caps are attached to the housing and/or the end walls by glueing. Alternatively, they may, however, also be attached by welding or a screw connection. In connection with those alternatives it may be suitable to include further sealings between the housing, the end caps and the end walls. Examples of such sealings in the form of sealing rings are shown in the above mentioned patents.

A good distribution of the second fluid is provided, if the housing is designed at each end with a widened part providing a peripheral channel for said fluid.

A great advantage of the present invention is that one and the same housing may be combined

with different kinds of end caps having different kinds of connection nipples for the connection of tube connectors of different kinds. Further advantages are:

Optimal distribution of dialysate and other fluids around the bundle in the "head area" affected by the thickness, height and number of the fins provided by the house, the end cap and the support ring.

Support of the bundle before and during potting. By variation of the inner diameter of the support ring it is possible to vary the bundle diameter.

The support ring deviates forces caused by e.g. fiber shrinkage into the housing and reduces therefore the load on the glue seam between the end walls and the headers or end caps.

All connectors may be placed at the headers; simple injection moulding tool for the housing;

constant wall thickness of the housing allows general minimization of the wall thickness;

the same housing may be used for hemofilters and hemodialyzers;

a symmetric housing is easy to handle during production and assembly.

No direct connection between the end walls and the housing;

recycling of housing possible;

the risk for cracks between the housing and the end walls is eliminated or at least reduced. Such cracks are often created during steam sterilization.

#### SHORT DESCRIPTION OF THE DRAWINGS

Fig 1 shows a first embodiment of the apparatus according to the invention.

Fig 2 shows a second embodiment provided with modified end caps.

Fig 3 shows in a larger scale schematically a part of a third embodiment.

#### PREFERRED EMBODIMENTS OF THE INVENTION

The embodiment shown in fig 1 includes a housing 1 enclosing a bundle of hollow fibers 2 which are arranged between two end walls 3 of moulded polyurethane. The ends of the open ended housing 1 is closed by two end caps 4 with an inlet 5 for a first fluid and an outlet 6 for the same fluid. The end caps 4 are, furthermore, provided with an inlet 7 for a second fluid and an outlet 8 for the same fluid. The inlet 5 and the outlet 6 for the first fluid is provided with an inner screw thread 9 and 10, respectively. The inlet 7 and the outlet 8 for the second fluid is instead provided with a simple outer screw connection 11 and 12, respec-

tively. The housing 1 is at its end provided with a widened part 13 providing an inner peripheral channel 14. The polyurethane material of the end walls 3 is prevented from reaching the housing 1 by a ring 15 which is shown in larger scale in fig 3.

The embodiment shown in fig 2 corresponds essentially to the one shown in fig 1. The same reference numerals have therefore been used for corresponding details, but with the addition of a. The only difference is that the inlet 7a and outlet 8a for the second fluid have been modified by being given a more complete outer screw thread 11a and 12a, respectively. Said inlet 7a and said outlet 8a have furthermore been given a groove 11a' and 12a', respectively. By the combination of the screw threads 11a and 12a and the grooves 11a' and 12a' the inlet 7a and outlet 8a may be used together with different kinds of tube connectors. This is described more in detail in the European patent application 91.101006.4, filed 91.01.26. The screw threads 11a and 12a are intended to be used together with simple screw connectors and the grooves 11a' and 12a' are intended to be used together with more complicated connectors of the so called Hansen-type.

The embodiment shown in fig 3 corresponds essentially to the embodiments shown in fig 1 and 2. The same reference numerals have therefore been given to corresponding details, but with the addition of b. A bundle of hollow fibers 2b is arranged longitudinally in a housing 1b between two end walls 3b of which only one is shown in the figure. An inlet 5b for a first fluid is provided with an inner screw thread 9b. The nipple 8b is here shown to be an inlet. Consequently, the apparatus according to the invention may be designed either for a concurrent or a counter-current flow. The nipple 8b can also be provided with some kind of tube connecting means. One possibility is, however, that a tube is pressed with a pressfitting in upon the nipple 8b. The ring 15b is provided with an inner part 15b' and an outer part 15b" separated by one or more ducts 16b. Between the housing 1b and the ring 15b there is provided one or more channels 17b through which the second fluid may flow from the nipple 8b to the peripheral channel 14b, which is arranged between two flanges 18b and 19b. Between the end cap 4b and the end wall 3b there is preferably a layer of glue 20b. A second layer of glue 21b is preferably arranged between the widened part 13b of the housing 1b and the end cap 4b. The attachment and the sealing may, however, also be provided as mentioned above by other means.

The invention is of course not restricted to only the above described embodiments. It can instead be varied within the scope of the following claims. The design of the different details may, for in-

stance, be varied within wide limits. Furthermore, you need by filtration normally only one outlet for the second fluid. Any inlet for said fluid is not necessary by such a use.

### Claims

1. An apparatus for effecting mass and/or heat transfer, including a cylindrical open-ended housing (1) closed by two end caps (4), each provided with an inlet (5) or an outlet (6) for a first fluid intended to flow through a bundle of hollow fibers (2) arranged within the housing (1) between two end walls (3), at least one of said end caps being provided with an outlet (8) for a second fluid intended to be removed from the space outside the fibers (2), the inlets and/or outlets (5-8) provided in one and the same end cap being separated by the adjacent end wall (3), characterized by a ring (15) arranged in the housing (1) and/or the end cap (4) in such a way that a channel or channels (17) is/are provided, connecting said outlet (8) for the second fluid with the space outside the fibers (2).
2. An apparatus according to claim 1, characterized in that one of the end caps (4) is provided with an inlet (7) for said second fluid and the other end cap (4) with an outlet (8) for the same fluid.
3. An apparatus according to claim 1 or 2, characterized in that the ring (15) is partly moulded into the adjacent end wall (3).
4. An apparatus according to any of the preceding claims, characterized in that the ring (15) consists of an inner part (15b' in fig 3) facing the fibers (2) and intended to support the fibers during the moulding of the adjacent end wall (3) and an outer part (15b" in fig 3) facing the housing (1) and/or the end cap (4) and being supported by the housing (1) and/or the end cap (4).
5. An apparatus according to claim 4, characterized in that said inner and outer parts (15b', 15b") are separated by one or more ducts (16b) which are filled by the moulding material in connection with the moulding of the end walls (3).
6. An apparatus according to any of the preceding claims, characterized in that said channel or channels (17) is/are arranged between an inner wall of the housing (1) and an outer wall of the ring (15).
7. An apparatus according to any of the preceding claims, characterized in that the inner main wall of the housing (1) and the inner wall of the ring (15) are essentially in line, supporting the bundle of hollow fibers (2) during the moulding of the end walls (3).
8. An apparatus according to any of the preceding claims, characterized in that the end caps (4) are attached to the housing (1) and/or the end walls (3) by glueing.
9. An apparatus according to any of the preceding claims, characterized in that the housing (1) is provided at each end with a widened part (13) providing a peripherial channel (14) for the distribution and/or collection of said second fluid.
10. An apparatus according to any of the preceding claims, characterized in that one and the same housing (1) is adapted to be combined with different kinds of end caps (4) having different kinds of connection nippels (5-8) for the connection to tube connectors of different kinds.

Fig.1

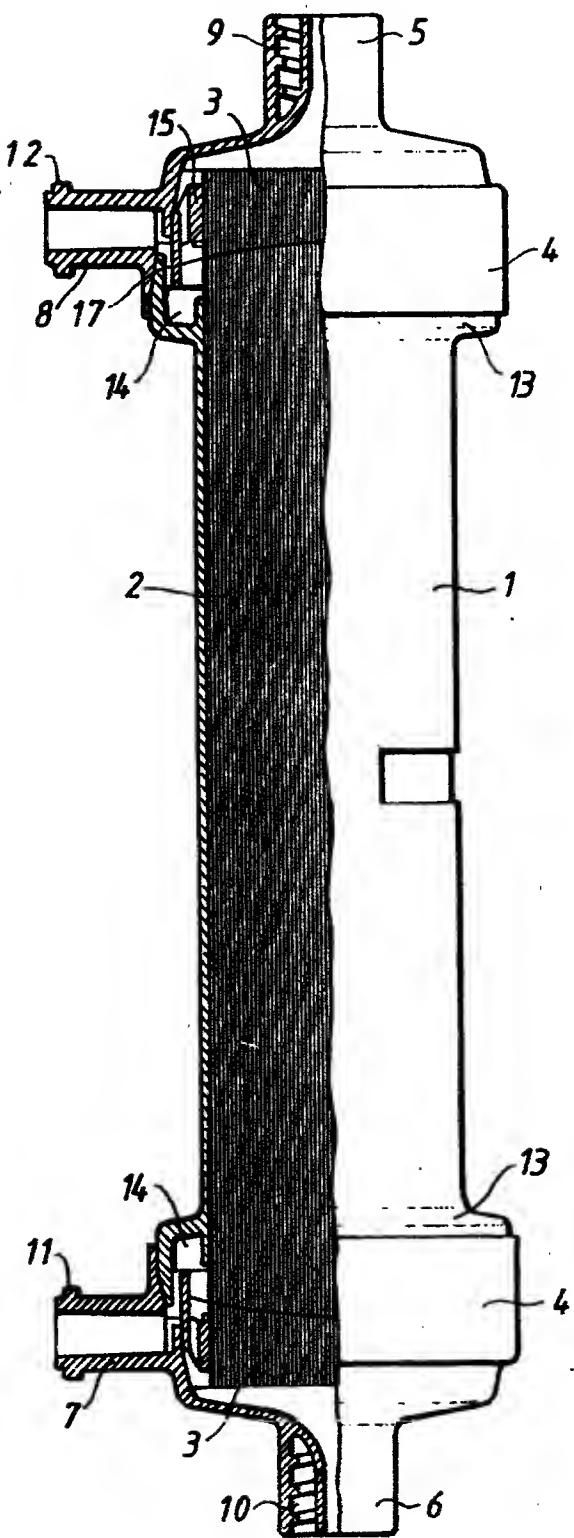


Fig. 2

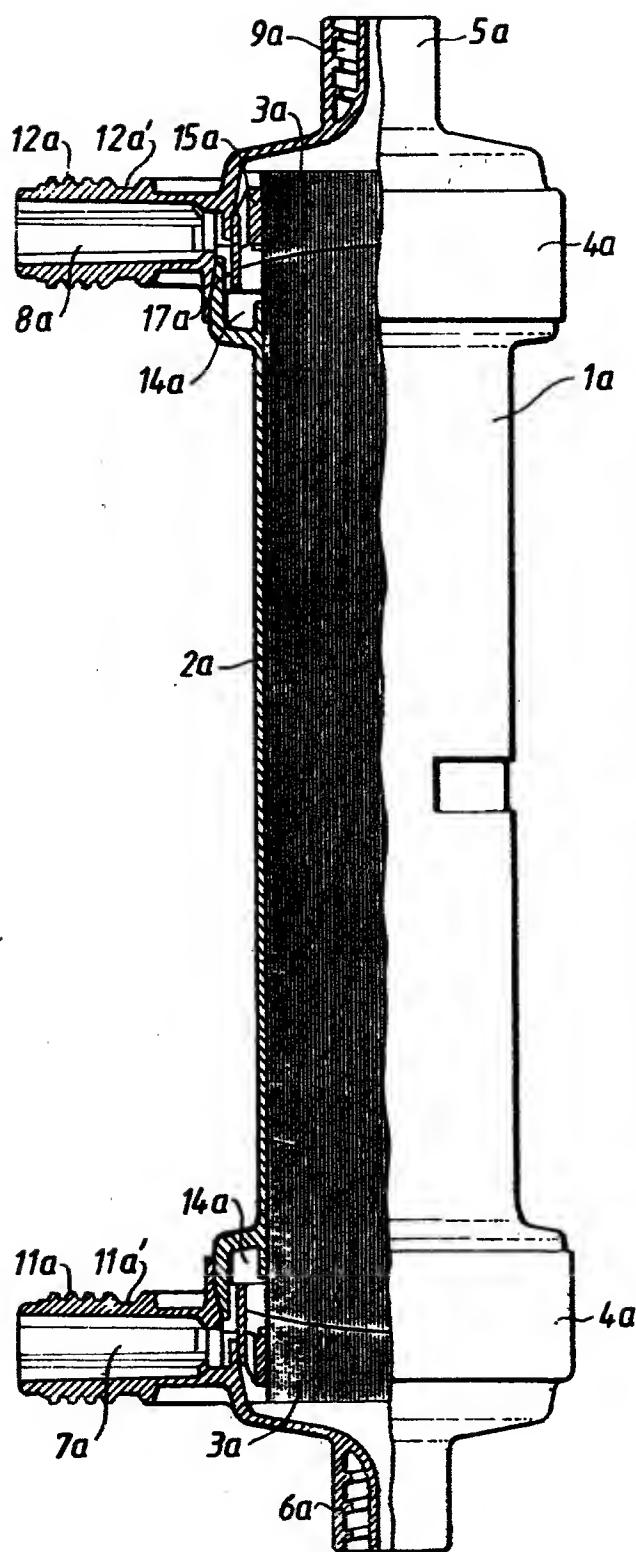
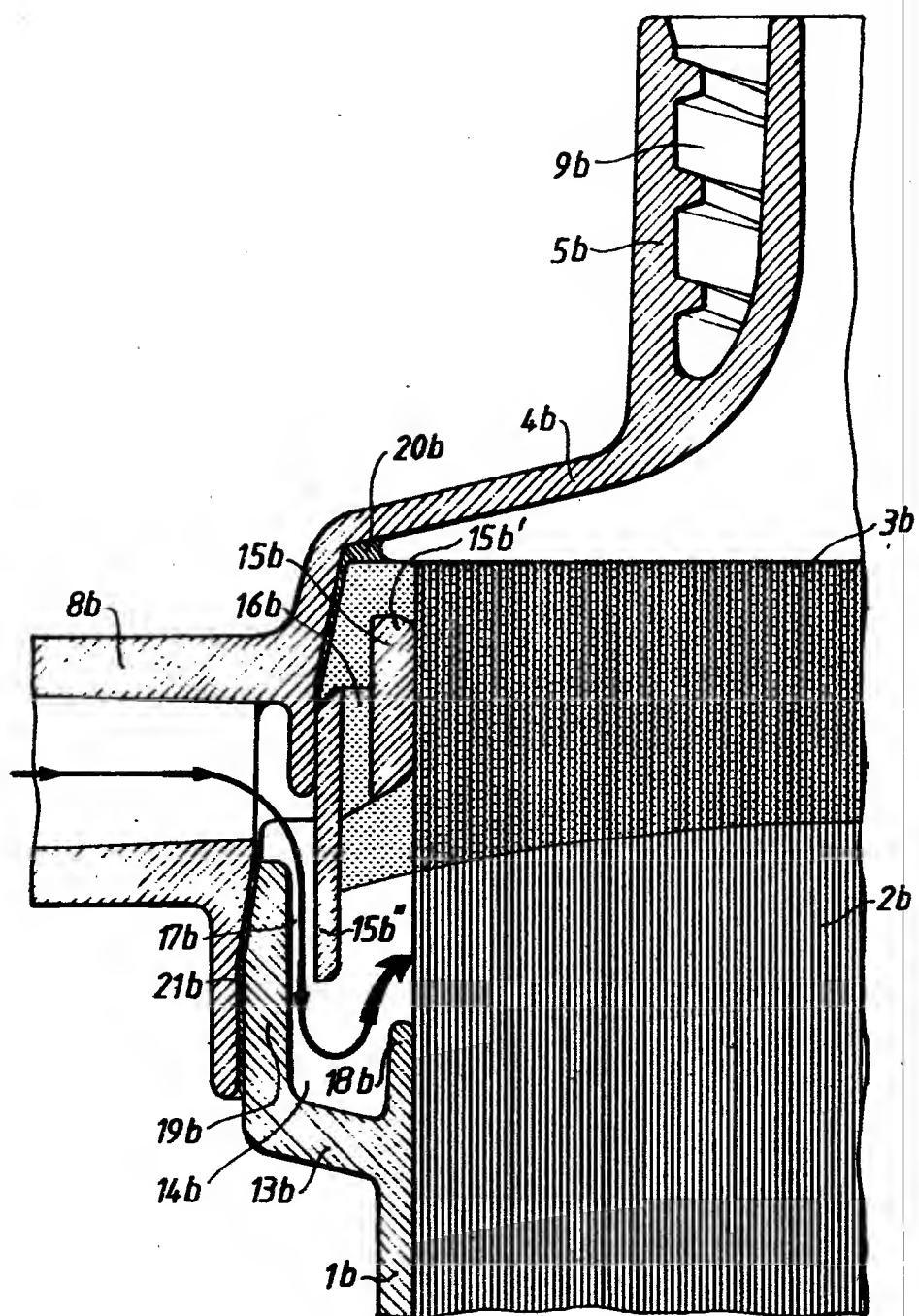


Fig. 3





EUROPEAN SEARCH REPORT

EP 92108412.5

| DOCUMENTS CONSIDERED TO BE RELEVANT   |  |                                  | CLASSIFICATION OF THE APPLICATION (Int. Cl.5) |
|---|--|----------------------------------|---|
| Category  | Citation of document with indication, where appropriate, of relevant passages                        | Relevant to claim                |   |
| D, A  | <u>US - A - 4 990 251</u><br>(KURT SPRANGER et al.)<br>* Abstract; claims 1-13 *<br>--               | 1-10                             | B 01 D 63/02                                  |
| D, A  | <u>US - A - 5 002 668</u><br>(KURT SPRANGER)<br>* Abstract; claims 1-7 *<br>--                       | 1-10                             |   |
| A   | <u>EP - A - 0 343 359</u><br>(TERUMO KABUSHIKI KAISHA)<br>* Abstract; fig. 1;<br>claims 1-13 *<br>-- | 1-10                             |   |
| A   | <u>EP - A - 0 360 133</u><br>(AKZO N.V.)<br>* Abstract; claims 1-3 *<br>--                           | 1-10                             |   |
| A   | <u>DD - A - 285 722</u><br>(TATABANYAI BANYAK VALLALAT)<br>* Abstract; fig. 1;<br>claims 1-3 *<br>-- | 1-10                             |   |
| A   | <u>US - A - 4 950 391</u><br>(LUDWIG WEICKHARDT)<br>* Abstract; claims 1-7 *<br>----                 | 1-10                             | B 01 D  |
| The present search report has been drawn up for all claims  |  |                                  | TECHNICAL FIELDS SEARCHED (Int. Cl.5)         |
| Place of search   |  | Date of completion of the search | Examiner                                      |
| VIENNA  |  | 06-10-1992                       | HAUK  |
| CATEGORY OF CITED DOCUMENTS   |  |                                  |   |
| X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>D : document cited in the application<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |  |                                  |   |